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DRAWINGS ATTACHED

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## (54) ELECTROGRAPHIC TABLET


(71) We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation established by Statute, of Kingsgate House, 66—74 Victoria Street, London, S.W.1., do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—


The present invention relates to apparatus for detecting point contact pressure, and is concerned in particular with an electrographic tablet.

A number of devices are known in which electric fields are produced in a resistive lamina such that a probe or other voltage sensitive device can derive output signals corresponding to its co-ordinate position on the surface of the lamina. Such devices have become known as electrographic tablets. An established practice is to energise the resistive lamina by means of continuous elongated electrodes which are generally mounted in parallel pairs to form a square or rectangle. By arranging that the ratio of the linear resistance of the bounding electrodes to the resistance per unit area of the lamina is very small, approximately linear fields can be produced across or down the resistive lamina.

One example of such apparatus is an electrographic writing apparatus in which a hand held probe is moved over the surface of a resistive lamina and derives from the lamina a voltage signal representing the position of the probe on the resistive lamina. The tablet is energised by producing in the surface of the resistive lamina electric fields which alternate between two orthogonal directions. The probe thus detects a voltage waveform which alternates between two d.c. values proportional to the $x$ and $y$ co-ordinates of the probe tip on the resistive lamina. The output of the probe is switched between two output channels in synchronism with the alternation of the fields in the resistive lamina, and the output from the two channels is presented as a series of d.c. pulses, or continuous d.c. levels.

In another example of an electrographic tablet, two sheets of insulating material in register with one another each carry on the face opposed to the other sheet a plurality of parallel conductors, the conductors of one sheet being orthogonal to the conductors of the other sheet. One set of conductors are energised electrically, and the two sets are normally separated by an air gap. Upon point contact pressure being made to the tablet, the sheets are pressed together at that point, the conductors at this point contact each other electrically, and signals are derived from terminals at the ends of the conductors to give voltage signals representing the co-ordinates of the point of contact.

According to the present invention there is provided an electrographic tablet comprising first and second laminae each having a surface comprising electrically conductive material, the two laminae being registered but separated by a foraminous sheet of insulating material, the laminae and the foraminous sheet being so arranged that pressure by a point contact on one of the laminae produces electrical contact between the laminae through the holes of the foraminous insulating sheet, means for energising one of the laminae in such a manner that when electrical contact is established between the laminae at a point, signals may be detected from one or both sheets which represent the co-ordinates of the point of contact.

The laminae may consist of insulating synthetic plastic material each carrying a plurality of parallel conductors on the mutually confronting faces of the laminae, the conductors of one laminae being orthogonal to the conductors of the other lamina.

In a preferred arrangement, the first and second laminae may consist respectively of a lamina of resistive material, and a sheet of resiliently deformable, electrically conducting material, and the energising means may comprise means for producing in the surface of the resistive lamina electric fields such that at any position within a predetermined area on the surface of the lamina, signals

may be detected which represent the co-ordinates of that position.

The lamina of resistive material may comprise a sheet of resistive material such as "Teledeltos" (Trade Mark) resistive paper, or a resistive coating on a base, such as a tin oxide coating on glass.

The foraminous sheet is preferably a woven, knitted or otherwise formed fabric or gauze in which the elements of the fabric or gauze are resiliently deformable so that point contact pressure on the conducting layer displaces the elements of the fabric or gauze to allow contact between the conducting layer and the resistive lamina.

A particularly preferred fabric for the insulating sheet is nylon in the form commonly used for ladies' stockings. In such material the elements of the fabric have a twist imparted to them which allows the elements to spring back into place after removal of a point contact pressure.

It is preferred that the conducting sheet is also formed of a fabric or gauze such as carbon or silver loaded, woven fibre glass or nylon.

There may be provided terminal means attached to the conducting layer and adapted to provide an output signal consisting of signals picked off from the resistive lamina by point contact pressure on the conducting sheet.

There may be provided a further protective layer over the conducting sheet to reduce wear, or damage by the point contact.

It is one advantage of the invention that information may be written on the tablet by any conventional pencil or by a pointed writing stylus which leaves no mark. It is not necessary to write with a special probe carrying an electrical lead, which commonly spoils the normal writing action. The apparatus is useful for tracing from a drawing placed over the conducting sheet, in which case a non-writing stylus is used. Alternatively, a sheet of ordinary paper can be placed on the conducting sheet and a drawing can be made on the paper with a normal pencil, the drawing also being detected by the tablet.

It is another advantage that, although point contact pressure produces contact between the conducting sheet and the resistive lamina, a diffuse pressure, such as that of a hand resting on the tablet, does not cause such contact, and therefore does not interfere with the action of writing.

Conveniently the field generating means may comprise four elongated resistive electrodes arranged as described in the specification accompanying our co-pending patent application No. 31243/67 (U.K. Specification No. 1,255,001). In this arrangement there are provided four elongated resistive electrodes connected in series approximately in the form of a rectangle and maintained in electrical contact with the resistive lamina, and one or more terminal means connected to each electrode, each pair of opposite electrodes being adapted to produce in the resistive lamina a substantially uniform potential gradient when energised by a potential difference applied across the opposed terminals of the pair of opposite electrodes, the electrodes being so shaped that the distance between directly opposed points on opposite pairs of electrodes decreases with displacement of the opposed points from the nearest adjacent terminal.

The tablet may be energised by means for energising periodically alternate pairs of opposite electrodes to produce alternately first and second potential gradients across the surface of the lamina at right angles to one another.

Also conveniently the electrodes may be energised by apparatus described in the specification accompanying our co-pending application No. 60943/68 (U.K. Specification No. 1,267,669). In the apparatus of this specification there is provided an electrographic tablet having four elongated resistive elements arranged substantially in the form of a rectangle on a resistive lamina, a centre tapped transformer, rectifying means connecting the output of the transformer across a pair of diagonally opposed corners of the rectangle, and connecting the said pair of corners to one of the remaining corners, in a sense as to allow current flow from the transformer to the said pair of corners, and from the said pair of corners to the said one remaining corner, the other remaining corner being connected to the centre tap of the transformer, and the arrangement being such that in operation, in successive half cycles of the transformer output alternate opposite pairs of electrodes are energised to produce electric fields in the resistive lamina which alternate between orthogonal directions.

Conveniently the elongated resistive elements may consist of spirals of resistance wire such as nickel-chromium alloy wire, and the spirals may be kept in contact with the resistive lamina by a housing pressing the spirals against the lamina.

The output signals from the conducting sheet consist of two pulse trains which may be smoothed by filter circuits to provide unidirectional output voltages representing the co-ordinates of the position of the point contact. The output signals can be used in a variety of applications, for example the output voltages can be sampled and the information stored in a computer, or the information can be displayed on a cathode ray tube. The apparatus can be used for data transmission in graphic form, or as an electric pantograph.

It will be appreciated that the arrangement for energising the tablet may be

inverted, in that the upper conducting sheet may be energised and signals picked off from the lamina beneath the insulating foraminous sheet.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a block circuit diagram of an electrographic tablet embodying the invention;

Figure 2 shows an enlargement of the tablet of Figure 1; and

Figure 3 is a section along the lines III—III in Figure 2.

Figure 1 shows by way of example one embodiment of an electrographic tablet. The apparatus has for its purpose the production of two electrical output signals representing the x and y Cartesian co-ordinates of a selected point with a frame of reference, the position of the selected point being movable within the frame.

A lamina 11 of resistive material such as a coating of carbon on a glass base 10 is arranged with four resistive electrodes 14, 15, 16 and 17 constituted for example by "Nichrome" (Registered Trade Mark) wire spirals pressed against the layer of carbon in good electrical contact therewith. The electrodes are arranged approximately in the form of a square, but, in a preferred arrangement, the electrodes are bowed inward slightly from a true square to reduce the so-called "pin cushion" distortion of the fields in the film.

As is shown in more detail in Figures 2 and 3, there is superimposed on the resistive coating 11 a conducting sheet 32 separated from the coating 11 by an insulating sheet 33. An enlargement of part of the tablet is shown in Figure 2, and a section of the tablet is shown in Figure 3. Both sheets 32 and 33 are preferably of fabric or gauze material. The conducting sheet 32 may for example be a woven sheet of carbon or silver coated fibreglass, and the insulating sheet 33 may be a nylon mesh of the type used for ladies' stockings, for example 20 denier stocking material. This has the advantage that the strands of the nylon material 33 can be pushed aside by point contact on the conducting fabric sheet 32, and will regain their original positions when the pressure is removed. The advantage of using a fabric or gauze for the conducting sheet is that the cross-over points of the strands of the material produce slight projections on the under surface of the sheet 32, and these assist in penetrating the spaces in the insulating sheet 33.

There may also conveniently be provided a thin protective sheet 34 of a smooth resilient material such as "Mylar" (Trade Mark) or other synthetic plastics material, preferably electrically non-conducting. This may be placed over the conducting layer 32 to reduce wear or damage to the conducting layer 32 by the stylus 23.

As an example of a method of energising the tablet, generating means 19 may feed flat topped voltage pulses alternately to a pair of opposite corners of the tablet 10. The four corners of the square of electrodes 14 to 17 are labelled by the reference numerals 1, 2, 3 and 4 and are connected electrically as follows. The corners 2 and 4 are maintained at all times during operation at V volts and at earth potential respectively, and the other two corners 1 and 3 are connected to the outputs of the generating means 19. By way of example, the voltage V may be 10 volts.

An output lead 24 from the conducting sheet 32 is connected to an emitter follower circuit 25 the output of which is fed to two gates 26 and 27 connected respectively in two channels A and B of the apparatus. The outputs of the gates 26 and 27 are connected to smoothing filters 28 and 29 respectively and these in turn feed the required output voltages to output terminals 30 and 31. The gates 26 and 27 are controlled by the *A* channel and *B* channel outputs respectively of the generating means 19.

The manner of operation of the apparatus is as follows. The generating means 19 generates two substantially square pulse trains with a phase difference of 180°. These trains drive the corners 1 and 3 alternately to a voltage V equal to the voltage at which the corner 2 is maintained throughout operation, that corner of the corners 1 and 3 which is not driven at any instant being held at earth. The effect is that there is applied across the terminals 1 and 3 a potential difference V of periodically reversing polarity. The result is that during one half cycle the electrodes 14 and 16 are maintained at substantially constant voltages of V volts and O volts respectively, and during the other half cycle the electrodes 15 and 27 are maintained at substantially constant voltages of V volts and O volts respectively. The electrodes which are not directly energised in each half cycle (e.g. 15 and 17) act as potentiometers to maintain the potential gradient between the two energised electrodes (e.g. 14 and 16) substantially unidirectional in a direction at generally right angles to the energised electrodes (e.g. 14 and 16). In the next half cycle the functions of the pairs of electrodes are interchanged.

When point contact pressure is applied to the conducting sheet 32, through the protective sheet 34, the sheet 32 picks off the instantaneous voltage at its point of contact with the resistive lamina 11, and this voltage is proportional to the distance of the point of contact from that electrode which is at earth potential at the instant considered. Thus if the electrodes 14 and 16 are energised, the voltage at the point of contact will be pro-

portional to the distance from the contact point to the electrode 16, and this voltage represents the $y$ co-ordinate of the contact point. When the generating means 19 moves to the next half cycle, the voltage at the point of contact changes to a proportion of $V$ volts dependent upon the distance of the point of contact from the electrode 17. This voltage represents the $x$ co-ordinate of the point of contact.

The voltage derived by the sheet 32 is amplified by the emitter follower 25 and fed to gates 26 and 27 which are controlled by the outputs of the generating means 19 to separate the $x$ and $y$ co-ordinate voltages. The pulses from the gates 26 and 27 are then smoothed by the filters 28 and 29 to produce at terminals 30 and 31 voltage levels $v_y$ and $V_x$ representing the co-ordinates y and x of the point of contact.

WHAT WE CLAIM IS:—

1. An electrographic tablet compriaing first and second laminae each having a surface comprising electrically conductive material, the two laminae being registered but separated by a foraminous sheet of insulating material, the laminae and the foraminous sheet being so arranged that pressure by a point contact on one of the laminae produces electrical contact between the laminae through the holes of the foraminous insulating sheet, means for energising one of the laminae in such a manner that when electrical contact is established between the laminae at a point, signals may be detected from one or both sheets which represent the co-ordinates of the point of contact.

2. An electrographic tablet as claimed in Claim 1, in which the foraminous sheet is a woven material.

3. An electrographic tablet as claimed in Claim 1, in which the foraminous sheet is a knitted material.

4. An electrographic tablet as claimed in Claim 2 or 3, in which the filamentary elements of the foraminous sheet have a twist imparted to them whereby such elements spring back into place after removal of a point contact pressure.

5. An electrographic tablet as claimed in any preceding claim, in which the laminae comprise insulating synthetic plastic material each carrying a plurality of parallel conductors on the mutually confronting faces of the laminae, the conductors of one laminae being orthogonal to the conductors of the other lamina.

6. An electrographic tablet as claimed in any of Claims 1 to 5, in which one of said first and second laminae is resiliently deformable, said first and second laminae comprising electrically conductive sheet material, the conductive material of one lamina having a lower conductivity than that of the other lamina, and said energising means comprises means for producing in the surface of the lamina of lower conductivity, electric fields such that at any position within a predetermined area on the surface of the laminae, signals may be detected which represent the co-ordinates of that position.

7. An electrographic tablet as claimed in Claim 6, in which said energising means comprises means for applying a potential gradient to said lamina of lower conductivity alternately in each of two mutually orthogonal directions.

8. An electrographic tablet as claimed in Claim 6 or 7, in which the lamina of higher conductivity is the flexible lamina and comprises a fabric or gauze.

9. An electrographic tablet as claimed in Claim 8, in which the fabric or gauze is formed from electrically non-conductive fibres coated with an electrically conductive material.

10. An electrographic tablet as claimed in any preceding claim, including a protective layer covering said one lamina to which point contact pressure is to be applied.

11. An electrographic tablet substantially as hereinbefore described with reference to the accompanying drawing.

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Agent for the Applicants.

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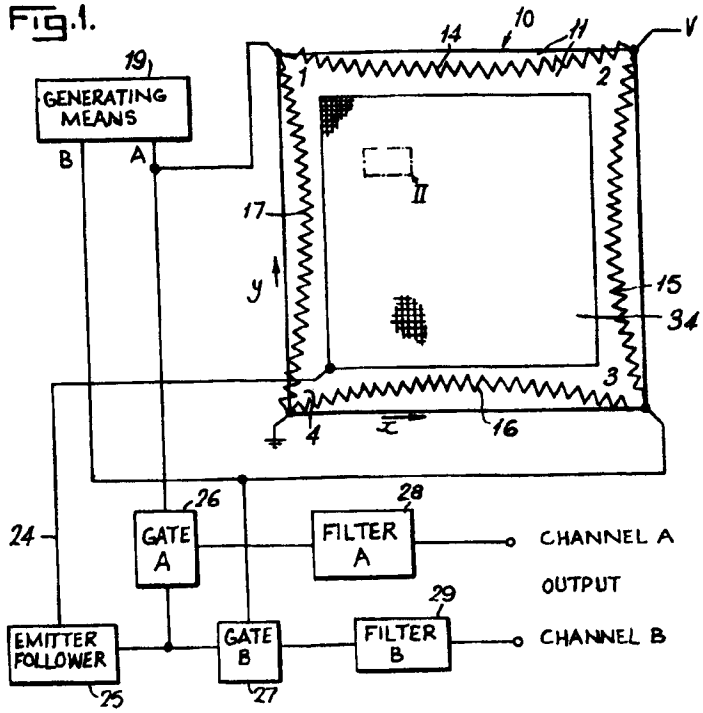
1331942 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig.1.



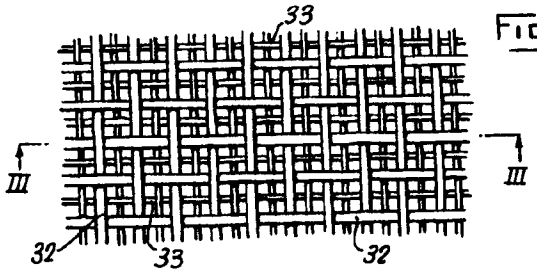




Fig.2.

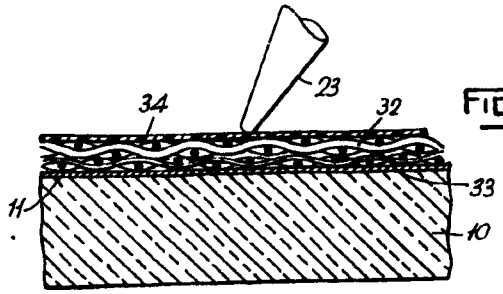



Fig.3.